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Reconnecting cognition in the lab and cognition in real life: The role of compensatory social and motivational factors in explaining how cognition ages in the wild

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Reconnecting Cognition in the Lab and Cognition in Real Life:

The Role of Compensatory Social and Motivational Factors in Explaining How Cognition Ages in the Wild

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Abstract

The papers in this Special Issue compellingly show that older adults' everyday cognitive life is governed not by the decline in elementary cognitive processes as measured in the lab, but by a multitude of compensatory mechanisms, most of which are of the social/motivational variety. Much of this compensatory behavior can be elicited with no or only little experimental prodding, underscoring the self-organizing or self-initiated nature of this type of behavior, even in advanced old age. We suggest that the study of compensation and the orchestration of cognitive, social, and motivational compensatory mechanisms in effective and healthy aging provides a meaningful challenge to traditional ways of examining developmental changes in cognitive performance.

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Reconnecting Cognition in the Lab and Cognition in Real Life: The Role of Compensatory Social and Motivational Factors in Explaining How Cognition Ages in the Wild

Cognitive aging in the lab and in real life: The orchestration of cognitive, social, and motivational abilities to achieve individually meaningful goals

As stated in our original Call for Papers, the primary aim of this Special Issue was to present articles that describe cognitive and motivational mechanisms that allow older adults to compensate for age-related limitations in performance on complex cognitive tasks. One impetus for this call for papers – or call to arms – was the strong disconnect we perceived (as many others have, e.g., Blanchard-Fields, 2007; Hertzog, Kramer, Wilson & Lindenberger, 2008) between, on the one hand, the rather depressing findings reported in studies that examine age-related differences in basic or complex cognitive abilities and, on the other, simple observation in the wild, which suggests that older adults, generally speaking, do very well in their day-to-day life. By way of illustration, Figure 1 shows correlations obtained from two meta-analyses of large sets of studies comparing subjects of roughly the same age range – young adulthood to (late) middle age. One meta-analysis examined age-cognition relations using typical laboratory tests in an age range from 18 to 50 (Verhaeghen & Salthouse, 1997), the other examined a number of objective and subjective indices of job performance, a real-life outcome which arguably should be at least partially dependent on cognitive abilities (Ng & Feldman, 2008). Age-laboratory cognition relationships are all reliably negative, ranging from -.30 to -.19. In contrast, the age-job performance correlations, ranging from -.08 to .05, are either not significantly different from zero or significantly (but very slightly) positive. The 95% confidence intervals of the real-world outcomes do not overlap with those of the ability measures, suggesting that these two aspects of performance are disjoint sets. We would argue that this disconnect between 'pure' cognition in the lab and 'true' cognition in the wild is one of the most important puzzles in the study of cognitive aging.

A second impetus comes from recent discoveries in the neuroscience of aging, all demonstrating substantial amounts of functional modifiability, compensation, and plasticity of the human brain, even in very old age. These findings challenge the view that the essence of cognitive aging is proportional loss in effectiveness of cognitive functions (Craik & Bialystok, 2006; Jäncke, 2009; Lövdén, Bäckman, Lindenberger, Schaefer, & Schmiedek, 2010; Reuter-Lorenz & Cappell, 2008). This approach is perhaps best exemplified by the cognitive reserve hypothesis (Stern, 2009) and, especially, by Cabeza's concept of the posterior-anterior shift in aging (PASA) (Davis, Dennis, Daselaar, Fleck, & Cabeza, 2008), extended by Park and Reuter-Lorenz (2009) into the concept of 'neurocognitive scaffolding' – age-related shifts within the brain towards more frontal activation to compensate for declining neural structures and function elsewhere in the central nervous system. This evidence of correlations between cognitive functions and neural activations is supplemented by correlations between engagement in mentally enriching and socially stimulating activities and cognitive health and longevity (Hertzog et al., 2008), and has sparked a new generation of training studies aimed at improving or sustaining cognitive fitness in old age. This in turn has given rise to a lively debate as to whether the most effective interventions should be purely cognitive (e.g., computer-based working memory training) or rather include more real-life enrichment experiences (Buschkuehl et al., 2008; Hartman-Stein & La Rue, 2011; Lustig, Shah, Seidler, & Reuter-Lorenz, 2009; Stine-Morrow & Basak, 2011; Tang & Posner, 2009; Ybarra et al., 2008).

Our call for papers, then, was precipitated by the idea that the likely solution to the puzzle would be to explore how the individual orchestrates cognitive, social, and motivational abilities to achieve individually meaningful goals or, more simply, to perform complex cognitive tasks at a high level. Orchestration is key here. Consider the example of job performance: If basic abilities decline, then the individual would need to compensate for decline in any single skill by recruiting other single skills that are likely each below the maximum level of possible performance. In other words, any single ability predictor cannot explain the high level of complex job performance, while efficiency and adequacy of orchestration and compensation can (Zöllig, Eschen, & Martin, 2010). This framework of orchestration in the service of meaningful goals is a challenge to traditional ways of examining developmental changes in cognitive performance, and precisely this prompted the call for papers for this Special Issue.

Reconnecting cognitive aging in the lab and real life: Overview of this Special Issue

In our call for papers, we deliberately cast a wide net. What did we catch?

Figure 2 offers one way to summarize the papers – a tag cloud of the summaries of all fifteen papers. The size and contrast of the font reflects the frequency with which different words occur in the fifteen Abstracts. Unsurprisingly, the tag cloud gives large weight to the populations examined: 'adults', who are, in that order, 'older' or 'younger'. A second batch of terms informs us about what is being studied – ('prospective') ('source') 'memory', 'cognitive' 'performance', 'processing'. Less emphasis is given to the 'laboratory' versus 'everyday' dichotomy, but it is present. 'Mechanisms' and 'interventions' are mentioned, but the individual mechanisms or the nature of the interventions do not show up in the tag cloud. The conclusion here is that studies largely converge with regard to who is being studied; that here are some commonalities in what is being studied; but that the actual mechanisms or methods are too diverse to show up in a tag cloud. In other words, to capture the full diversity in conclusions, we do need to tunnel down to the level of the actual studies. This isn't all that unexpected. There is broad diversity in the cognitive-aging background used in the present collection of papers (e.g, Baltes's Selective Optimization with Compensation model, e.g., Baltes, 1997; Stern's cognitive reserve model, 2009; Park and Reuter-Lorenz's neurocognitive scaffolding model, 2009; the inhibition model of aging, Lustig, Hasher, & Zacks, 2007; the dual mechanism of control model; Braver, Gray, & Burgess, 2007). Likewise, even though all papers emphasize the role of motivational and meta-cognitive mechanisms in sustaining healthy aging, on this account too the palette is broad, with references to socioemotional selectivity model (Carstensen, Mikels, & Mather, 2006), to conceptualizations of 'motivational reserve' (Forstmeier & Maercker, 2008), to close relations between motivation, self-efficacy and cognitive functioning (Lachman, 2006), and to the extraordinary role of self-regulation in successful aging (Hertzog, Sinclair, & Dunlosky, 2010).

A more detailed (or at least more systematic) look at the fifteen papers is provided in Table 1. In this table, we summarize each study under four rubrics: the population studied, the topic or dependent variable, the type of examination conducted (correlational study, experimental study, practice study, or literature review), and the main conclusion, as we saw it, of the study. We realize that it is very uncharitable to reduce the work conducted in each of these papers to a single sentence; we do this solely for the purpose of a quick analysis of the contents of this Special Issue.

One immediately noticeable conclusion from Table 1 is that the papers cluster quite naturally into a few topic areas, with memory being the topic most clearly favored. There are at least two very good reasons for a strong interest in memory, retrospective or prospective. First, memory (at least as measured in the laboratory) shows a quite dramatic decline with age, leading to about a 1 SD difference between the average 20-year old and the average 70-year old in retrospective memory (Verhaeghen, Marcoen, & Goossens, 1993) and about a 0.75 SD difference in prospective memory (Henry, MacLeod, Phillips, & Crawford, 2004). This decline is also echoed in increasing memory complaints with age (e.g., Cavanaugh, Grady, & Perlmutter, 1983; Smith, Petersen, Ivnik, Malec, & Tangalos, 1996). Second, memory is an interesting case of assembled cognition, where the mental activity – strategies, learning orientations, and the like – plays as much a role in determining performance as the underlying memory 'ability' itself (e.g., Craik, 2002). It is this latter quality that makes memory and age differences therein so eminently malleable. The papers in this Special Issue bear this out, and report a number of compensatory (and/or otherwise performance-modifying) mechanisms. One converging finding in a number of the memory papers represented here, for instance, is that mood can quite dramatically influence the subject's orientation towards the material: Negative mood leads to smaller misinformation effects because negative mood promotes a more detail-oriented mode of processing (Hess et al., 2012, this issue); depressed mood leads to more ruminative processing, which enhances monitoring frequency in a time-based prospective memory task, which in turn increases performance (Albinski et al., 2012, this issue); mood modifies the effect of need for closure on encoding processes, again assumedly because mood shifts the subject's position on the detail-gist continuum (Kossowska et al., 2012, this issue). Another mechanism is the perceived importance of creating a memory: Prospective plans that are more important to the person are less easily forgotten (Ihle et al., 2012, this issue; Niedzwienska et al., 2012, this issue); a sense of social obligation makes to-be-remembered materials stand out more for older but not younger adults, and leads to higher performance in the former compared to the latter (Niedzwienska et al., 2012, this issue). A third mechanism, also observed in studies on text comprehension, is expertise, either operationalized as real-world background knowledge (individuals with more reading expertise have greater efficiency in low-level text processing and take more time to digest meaning at the end of a sentence, Magliano et al., 2012, this issue; older adults tend to benefit more for schema-consistent information, Shi et al., 2012, this issue) -- or as laboratory-acquired familiarity (extended practice on the embedded task leads to better prospective memory, even in the lab, Zoellig et al., 2012, this issue).

The studies focusing on more basic aspects of the cognitive system offer fewer demonstrations of malleability of this type. One theme here concerns the effects of extended practice (e.g., efficiency of switching operations is as malleable in younger as in older adults, and age differences in error rates decrease over practice; Strobach et al., 2012, this issue). Even in these basic abilities social/emotional/motivational factors come into play (e.g., perceived quality of life and perceived cognitive ability moderate training gain; McDougall et al., 2012, this issue). Given that there is possibly less room for improvement in such tasks than there is in more assembled types of cognition, it is heartening to see reports such as Li et al.'s, where older adults turn out to be very able to flexibly adapt secondary task performance in response to changing cognitive demands, even in a behavior as seemingly unthinking as walking. Laudate et al. (2012, this issue) demonstrate that very simple perceptual interventions can lead to quite striking improvements in cognitive performance in patients suffering from Alzheimer's disease or Parkinson's disease; likewise, a simple semantic orientation task without explicit guidance substantially improves performance on memory for pictures (Cherry et al., 2012, this issue).

We are also happy to note that quite a few of the papers in this Special Issue emphasize the point we made above about the disconnect between laboratory tasks and cognitive tasks as performed in daily life. This is clearest in the case of prospective memory, where the literature (for a meta-analysis, see Henry et al., 2004) shows a clean dissociation between age-related differences in the laboratory (where younger adults outperform older adults) and in daily life (where older adults outperform younger adults). Two papers explicitly examine this dissociation, and show that social/motivational factors such as commitment and self-rated importance of the task can explain some of the positive age differences in everyday prospective memory (Niedzwienska et al., 2012, this issue; Ihle et al., 2012, this issue). The quick summaries offered in the previous paragraphs also demonstrate that social/motivational and other non-cognitive factors – mood, commitment, perceived importance, perceived ability, self-efficacy, task familiarity, sensory enhancements, and aerobic fitness -- play a major role in the living cognitive ecology. Note that one of the basic tenets of experimental psychology is that a clear-cut design with deliberately impoverished stimuli puts all subjects on equal footing, that is, it abstracts the living ecology to the point where everyone is at an equal disadvantage. Many of the papers in this Special Issue showcase that this is not true: Taking cognition out of the wild and into the lab is specifically hurtful to older adults', not so much younger adults', performance.

Before we conclude, we would like to point out that one type of study is remarkably absent from this collection. We remark on its absence because it demonstrates an important recent shift in the field. This concerns the type of intervention study where participants receive explicit instruction in cognitive strategies. This type of work was quite popular towards the end of the twentieth century, and has perhaps most clearly been embodied in memory training studies and in studies training specific strategies for high-level cognitive abilities (e.g., Ball et al., 2002, and Verhaeghen, Marcoen, & Goossens, 1992). In the present set of articles, explicit strategy instruction has been replaced either by mere-practice studies, where subjects simply repeat a task over and over again, or by (a plea for) multimodal interventions, such as video gaming, where subjects practice a wide variety of skills, sometime coupled with physical/aerobic training. The absence of instruction studies could be seen as a sign of the growing maturation of the field, especially in how the aging individual is viewed. That is, in the present studies older adults are not seen as in need of instruction; the interventions or experimental manipulations are designed to hone or reawaken the existing repertoire, or else to allow the subjects to freely discover new strategies on their own. Interesting in this respect is that the one study (Cherry et al., 2012, this issue) that was explicitly designed to steer subjects towards the use of one particular strategy (clustering of pictorially presented concepts into semantic categories) employed a rather low-level orientation task rather than explicit instructions to achieve this goal. Despite the lack of explicit instruction, this study clearly resulted in the desired effect: Performance did increase in the condition designed to bolster clustering, and the effect could be traced to enhanced organizational strategies at encoding. In other words, with just a bit of external support, the older adults in this study (including the nonagenarians) were quite able to build or rebuild efficient strategy use. Likewise, the study by Li et al. succeeded in eliciting smart compensatory behavior from their older subjects in the secondary task, which neatly tracked the cognitive demands of the primary tasks in the complete absence of any instruction. Finally, Ihle et al., (2012, this issue) noted that older adults use prospective memory in a more flexible way than younger adults, fluidly reprioritizing planned intentions when needed. These and other data suggest that compensation, then, appears to be what older adults simply do – they don't need to be taught.

Briefly summarized, it is our feeling that this Special Issue contains a highly interesting set of fifteen studies that compellingly show evidence for the position that older adults' everyday life is governed not by the decline in elementary cognitive processes as measured in the lab, but by a multitude of compensatory mechanisms, most of which are of the social/motivational variety. Much of this compensatory behavior can be elicited with no or only little experimental prodding, underscoring the self-organizing or self-initiated nature of this type of behavior, even in advanced old age.

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Figure 1.
The disconnect between age-related cognitive decline in laboratory measures of cognitive abilities (perceptual speed, primary memory/working memory, spatial ability, episodic memory, reasoning; meta-analytic data from Verhaeghen & Salthouse, 1997) and age-related stability in everyday performance (job performance; meta-analytic data from Ng & Feldman, 2008), in subjects roughly between the ages of 18-59. Error bars denote 95% confidence intervals.

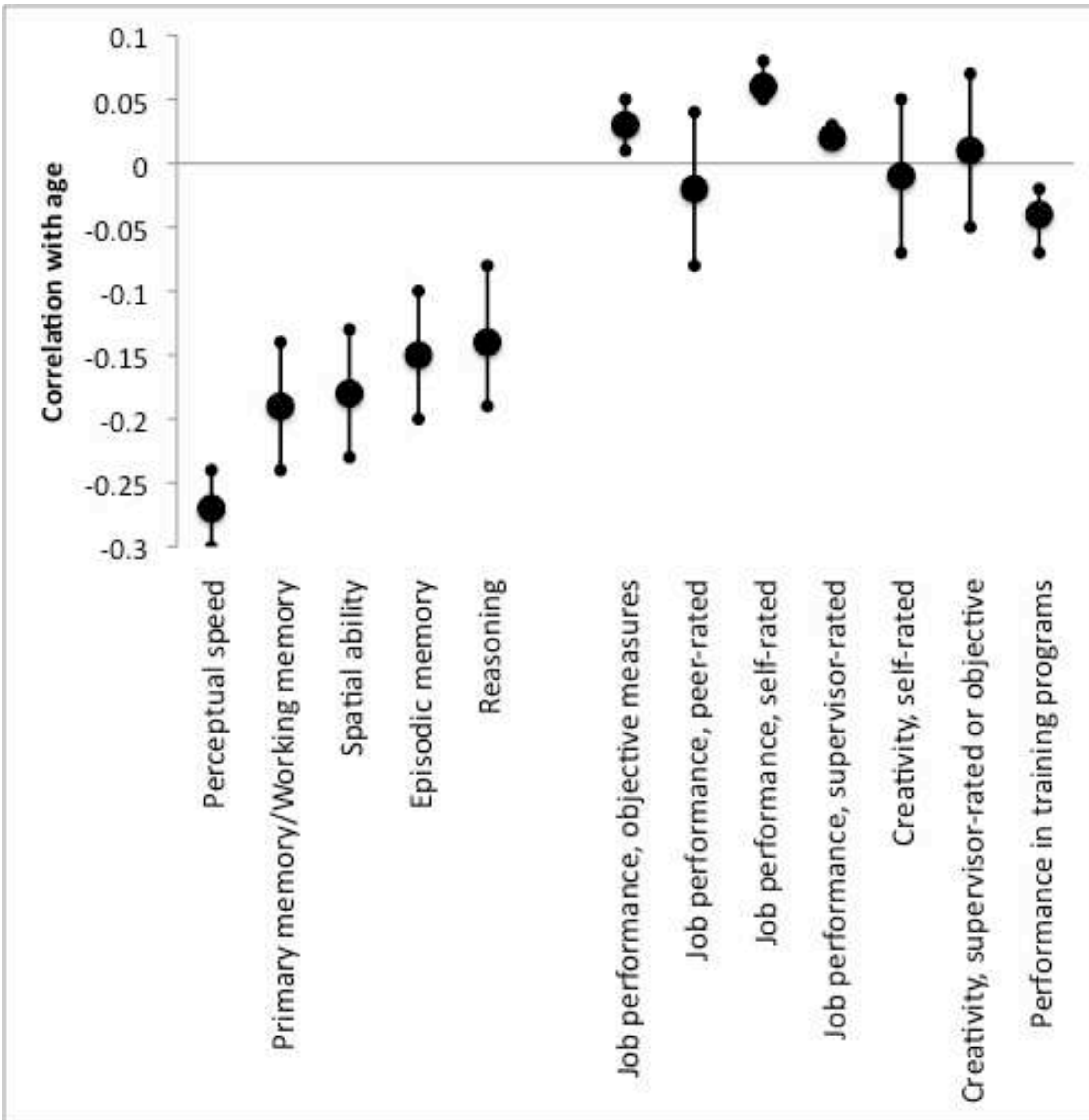

Figure 2.

Tag cloud representing the Abstracts of the fifteen papers in this Special Issue. The size and contrast of the font represents word frequency within the collection of Abstracts.

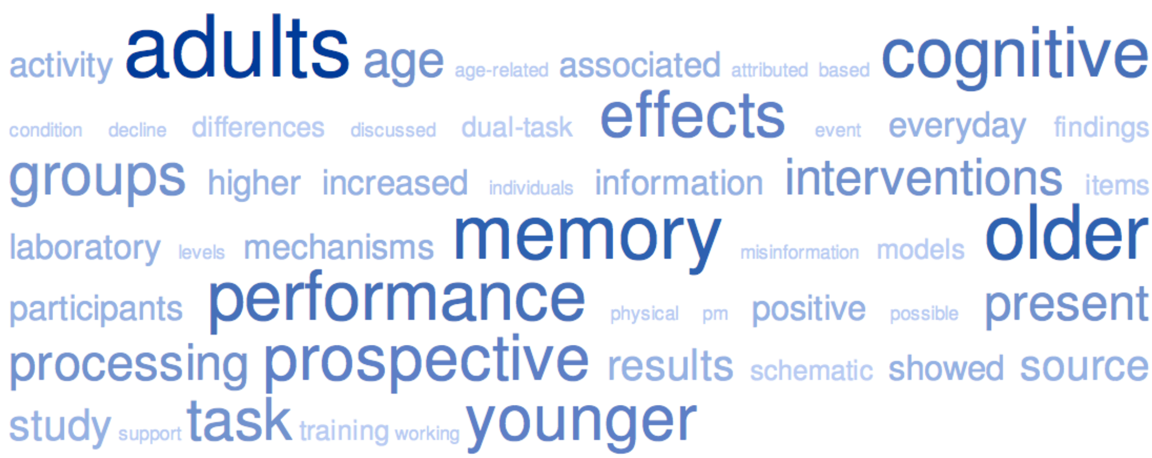

Table 1.

Summary of the main conclusions each of the fifteen papers in the Special Issue, as well as the population investigated, the topic of study and the type of study (YA = younger adults, MA = middle-aged adults; OA = older adults; AD = Alzheimer's disease, PD = Parkinson's disease).

Article	Population	Topic/Dependent variable	Type of study	Main conclusions
Hess et al.	YA, OA	Episodic memory (misinformation effect)	Experiment	Dominant positive mood leads to a larger misinformation effect and mediates age-related effects in misinformation; need for cognition leads to smaller misinformation effects.
Albinski et al.	depressed and non-depressed YA and OA	Prospective memory	Experiment	Depression can act as a compensatory mechanism in time-based prospective memory, due to enhanced monitoring.
Niedzwienska et al.	YA, MA, OA	Prospective memory	Experiment (lab/ecological)	Age-related differences in time- and event-based prospective memory favor younger adults in the lab, but older adults in everyday tasks, partially due to age differences in self-rated commitment; an experimentally manipulated sense of social obligation decreased performance in younger but not older adults.
Ihle et al.	YA, OA	Prospective memory	Diary	Older adults perform better than younger adults on everyday prospective memory tasks; self-rated importance of the task is an important mediator; older adults engage more often in flexible reprioritization of planned intentions.
Laudate et al.	YA, OA, AD,	Visual search	Experiment	Making stimuli in a Bingo game more

	PD		(ecological)	perceptually salient and decreasing the working memory load of the game improved performance in AD and PD patients.
Payne et al.	OA	Text comprehension, text recall	Correlational	Individuals with higher levels of print exposure over a lifetime show greater efficiency in word-level processing and take more time to process information semantically at clause boundaries; print exposure mitigates the effects of working memory load on semantic processing at clause boundaries.
Li et al.	YA, OA	Dual task performance (gait)	Experiment	In a dual-task situation, older adults, but not younger adults, successfully adapt their stride to slow the cadence of walking in response to increasing cognitive demands.
Zöllig et al.	OA	Prospective memory	Experiment	Familiarization with the task in which a prospective memory task is embedded decreases response time to the prospective task and decreases the number of false alarms.
McDougall et al.	OA	Cognition (many aspects)	Practice	Repeated exposure to Nintendo Brain Training increases performance on digits Backwards; perceived quality of life and perceived cognitive ability are strong determinants of training outcomes.
Strobach et al.	YA, OA	Dual task performance	Practice	Both younger and older adults benefit from extended practice on an auditory-visual dual task, due to improvements in the switching operation; age differences in response time do not change over the course of training, but

				age differences in error rates do shrink.
Kraft	(none)	Cognition (many aspects)	Literature review	A review of the intervention literature argues for the implementation of multimodal (physical and cognitive) interventions.
Magliano et al.	YA, OA	Text comprehension	Experiment	In spite of age-related differences at the surface-form and textbase level, situation-model representations as measured by text segmentation are largely intact in older adults, even for pictorial narratives.
Kossowska et al.	YA, OA	Episodic memory (schema effects)	Experiment	Mood moderates age effects in the effect of need for closure on schema-based memory – when in a positive mood, the relationship between need for closure and schema-consistent processing is identical for the two age groups; this is not the case during negative moods.
Shi et al.	YA, OA	Episodic memory (schema effects)	Experiment	No age differences in source-memory-related judgments of learning; older adults benefit more from schema-supported information than younger adults, whether or not the schema was presented before or after encoding.
Cherry et al.	MA, OA, very OA	Episodic memory (pictures)	Experiment	The pictorial superiority effect is intact in nonagenarians; semantic orientation leads to larger effects on pictures than words, with no age interactions; the oldest old do show some deficiencies in strategic processing.